Reliability and Quality through Processing: Beneficiation of High LOI Fly Ash for Concrete

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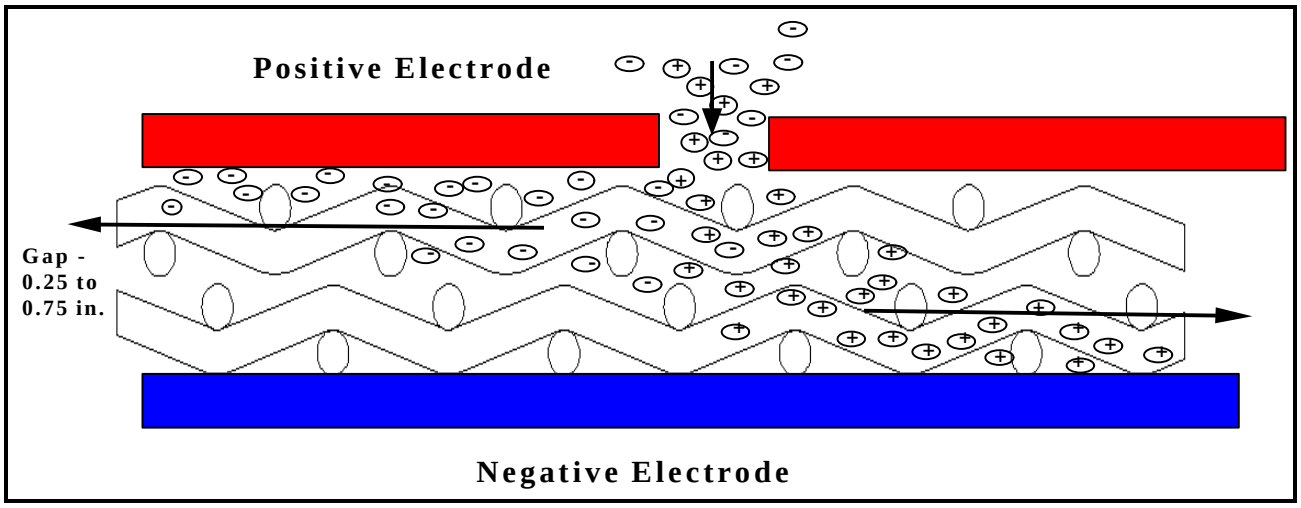
Three years of commercial operations has proven the Separation Technologies, Inc. (STI) electrostatic separator to be a reliable and cost efficient means to remove carbon from high Loss on Ignition (LOI) fly ash. The STI process produces uniform quality fly ash (±0.5 % LOI) from highly variable LOI ash. Presently, four STI electrostatic separators are operating at electric utilities to produce concrete-grade fly ash: New England Power(NEP) Brayton Point Station (2 separators), NEP Salem Harbor Station, and Carolina Power and Light (CP&L) Roxboro Station. STI is marketing ash from Roxboro under the name of ProAsh, LLC., a partnership with Roanoke Cement Corp. Additionally, a second separator will be installed at CP&L Roxboro to handle the entire plant production of 500,000 tons of ash, and a new installation at Jacksonville Electric's St. John's River Power Park is planned for 1999. These projects will bring the processing capacity of installed STI separators to 1 million tons per year.

STI TECHNOLOGY OVERVIEW

Separation Technologies, Inc. has developed a triboelectric separation process with a patented separator geometry that solves scale-up problems inherent to other electrostatic technologies. It is particularly effective with small, micron sized particles where other electrostatic technologies have failed.

In the STI separator, the material is fed into the thin gap between two parallel plane electrodes (See Figure # 1). The particles are triboelectrically charged by interparticle contact. With fly ash, the predominant differential charge transfer occurs between the mineral constituents and the residual carbon from the coal combustion. The particles are then swept up by a moving open mesh belt and conveyed in opposite directions. The moving belt sets up a counter current flow field independent of the electric field. The high voltage field need only move the particles a tenth of an inch to move a particle from a left-moving to a right-moving stream. The belt moves the particles adjacent to each electrode toward opposite ends of the separator. The counter current flow of the separating particles and continual charging by carbon - mineral collisions enables a multi-stage separation and results in excellent purity and recovery.

Figure # 1: Cross section of electrode area showing separation of charged particles.



The overall separator design is relatively simple. The belt and associated rollers are the only moving parts. The electrodes are stationary and composed of an appropriately durable material. The belt is a polymeric webbing. The overall separator electrode length is approximately 20 feet and the width is dependent on the capacity desired. The overall power consumption is about 1 kilowatt per ton of material processed with most of the power consumed by two motors driving the belt. The process operates at very high throughput levels, with commercial machines processing between 10 and 35 tons per hour.

The small gap, high voltage field, counter current flow, vigorous particle-particle agitation and self-cleaning action of the belt on the electrodes are the critical features of the STI separator resulting in excellent performance. The process is entirely dry, requires no additional materials other than the fly ash and produces no waste material or air emissions. The recovered materials consist of fly ash reduced in carbon content (LOI) to levels suitable for in concrete and a high carbon fraction which has fuel value for the generating plant.

Commercial History

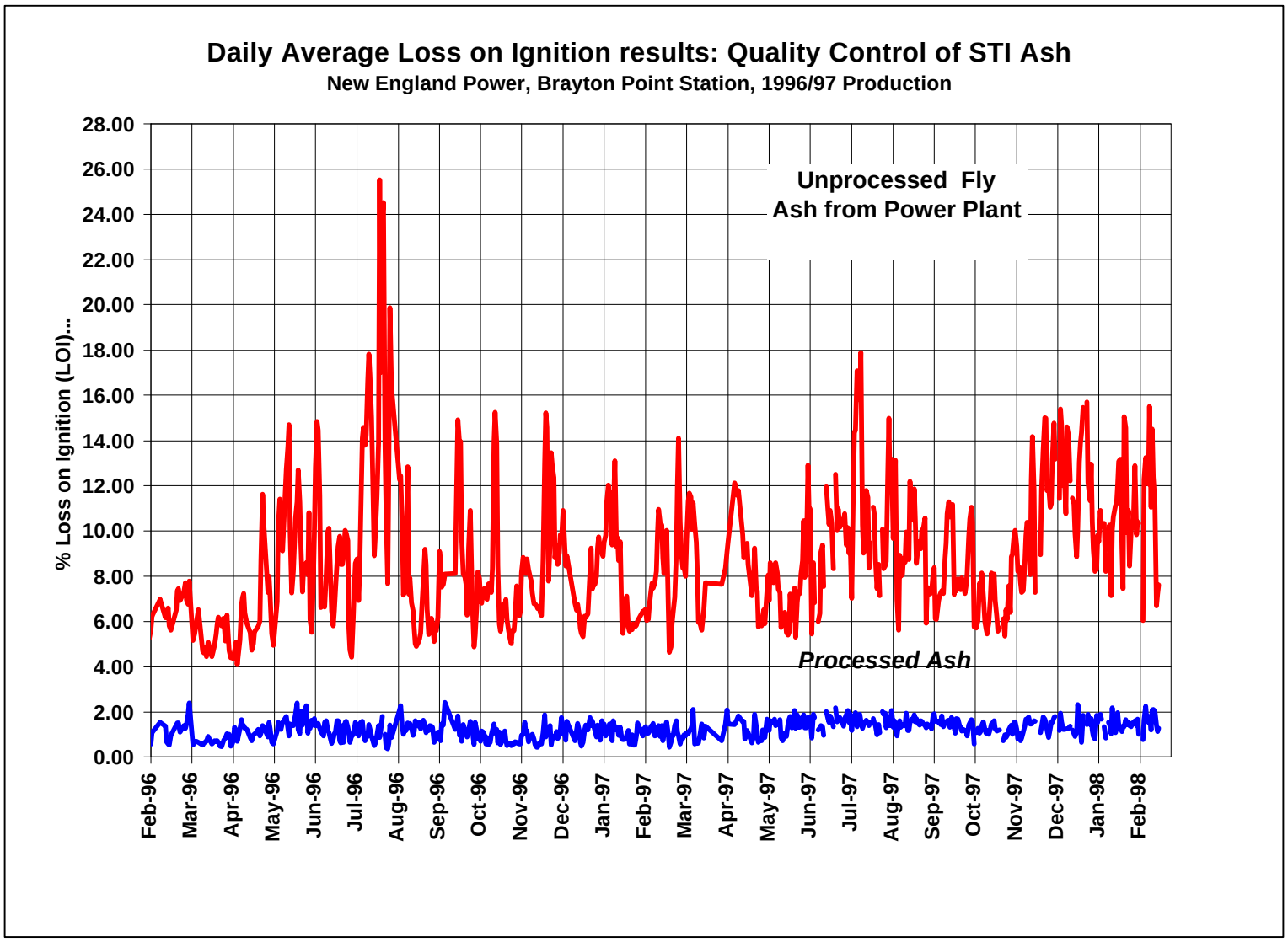
I. New England Power (NEP) Brayton Point Station

The first fully configured operation to produce fly ash using the STI electrostatic separation system was started up at the NEP Brayton Point Station in July, 1995. Brayton Point is a plant located approximately 45 miles southwest of Boston. This power plant burns bituminous coal from up to twenty different sources in three units producing 1100 megawatts of power, resulting in approximately 240,000 tons of fly ash per year. Before NOx conversion in 1995, the power plant produced relatively low (3 to 5%) LOI fly ash. All three coal fired generating units were converted to Low NOx burners to comply with the mandate of Phase I of the Clean Air Act of 1990. These conversions resulted in an increase of the fly ash LOI to levels (6 to 25%) unacceptable for use in ready mix concrete.

Production of ash at Brayton Point has increased with the demand for processed ash in the region. Sales were 16,500, 61,500, and 91,000 tons in 1995, 1996 and 1997 respectively. For 1998, sales are projected to exceed 120,000 tons of processed ash. To meet this demand for fly ash, a second separator was installed at Brayton Point in April of 1997. The combined processing capacity of the two separators exceeds 300,000 tons annually. The STI fly ash has gained wide acceptability in the New England market as well as New York state and Canada. The STI process has provided for a reliable source of consistent quality fly ash which in turn has allowed ready mix concrete producers to optimize the utilization of this material.

Figure #2 shows the LOI of the feed ash and STI produced ash. The LOI range of the feed fly ash varies anywhere between 4% and 25% and has an average value of 8.25%. Changes in LOI of 7% can occur in a matter of a few hours with changes in coal and boiler operations. Despite this high variability in LOI of incoming fly ash, the process is able to produce a consistent product with minimal rejected material. The average LOI for the processed product in 1997 was 1.34% with a standard deviation of 0.36 % for all shipments of ash sold in the New England / New York market.

Figure # 2: LOI control at NEP Brayton Point Station



II. Carolina Power and Light (CP&L) Roxboro Station

STI started a processing operation at the Carolina Power and Light Roxboro Generating Station in North Carolina in September, 1997. This project, ProAsh, LLC, is a joint venture of Roanoke Cement Company and STI. ProAsh is responsible for managing all ash; processing, marketing, and landfilling of both fly ash and bottom ash from the Roxboro plant.

The first separator with a design capacity of 35 tons per hour has the capability of beneficiating 260,000 tons of fly ash each year. This large separator has an electrode width of 42 inches: a 17 % greater area than the first machine installed at Brayton Point but an expected capacity of nearly double the earlier design. The capacity of the C.P. & L. Roxboro facility will be expanded to over 500,000 tons annually by addition of a second separator this summer (1998) to meet the demand for processed fly ash in the region.

The reduced LOI fly ash (*ProAsh*) is supplied to ready mix operations in Virginia, North Carolina, and South Carolina where it is utilized extensively to mitigate alkali silica reaction in concrete due to the use of reactive aggregate and unavailability of low alkali cement. The LOI of processed ash has been extremely consistent at Roxboro (See Figure # 3).: the LOI of shipments have averaged 1.9 % with a standard deviation of 0.19 % Due to the consistent LOI of the processed ash, customers have reported complete elimination of air entraining problems due to ash variability. With the high reliability of quality and supply provided by ProAsh, customers have expanded their utilization of ash considerably.

Figure # 3: LOI Control at CP&L Roxboro Station.